Space Weather Technical Forecast

Issued on Monday, 15 January 2024 at 01:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at Low levels, with the largest flare of the period a C9.6 peaking at 14/1206UTC, attributed to Ex-AR3538 beyond the northwestern limb. There are thirteen sunspots on the visible disc, two of which are currently unnumbered. Two large spots reside in the southeast, AR3545 and AR3549, these are both consist of large leader spots followed by smaller spots and pores of opposite polarities, the latter of which has developed a gamma configuration in the trailing region. The most complex region appears to be AR3541 in the southwest, which is set amongst a larger complex of sunspots. There is evidence of magnetic looping between regions, which may result in greater instability. There is a new and unnumbered sunspot emerging on the eastern limb. All other spots remain small and simple at present. No CMEs observed in the past 24 hours have any Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by DSCOVR at L1, have been indicative of background conditions perhaps with a weak transient arrival around 14/1715 UTC, though due to the lack of ACE observations to corroborate, confidence in specific parameters is low. Solar wind speeds are thought to be either slow/ambient or slightly elevated, which have ranged between 300-500 km/s, although solar wind data from DSCOVR was suspect, therefore low confidence. Density has been around average or below. The interplanetary magnetic field (IMF), Bt, has been weak throughout, at or below 7nT. The north-south component, Bz, was weak and mostly negative, fluctuating between +1/-7nT, though a more notable period of -Bz was observed beginning 14/0715UTC. Phi angle has been mostly positive (away from the Sun) throughout, although has recently become negative (towards the Sun) from 14/2000UTC. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at background levels.

GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. The associated 24-hour fluence was well below Active (1e8 integrated pfu) throughout. The 15/0000 UTC 24-hour integrated fluence observation was 2.01e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of isolated M-class activity throughout, and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. Wind speeds are expected to remain at similar levels, perhaps declining through day 1 (15 Jan). The high speed stream of CH92/+, with speeds of 450-500 km/s, may arrival late day 2 (16 Jan) or into day 3 (17 Jan), with the effects perhaps lingering into day 4 (18 Jan) before gradually waning.

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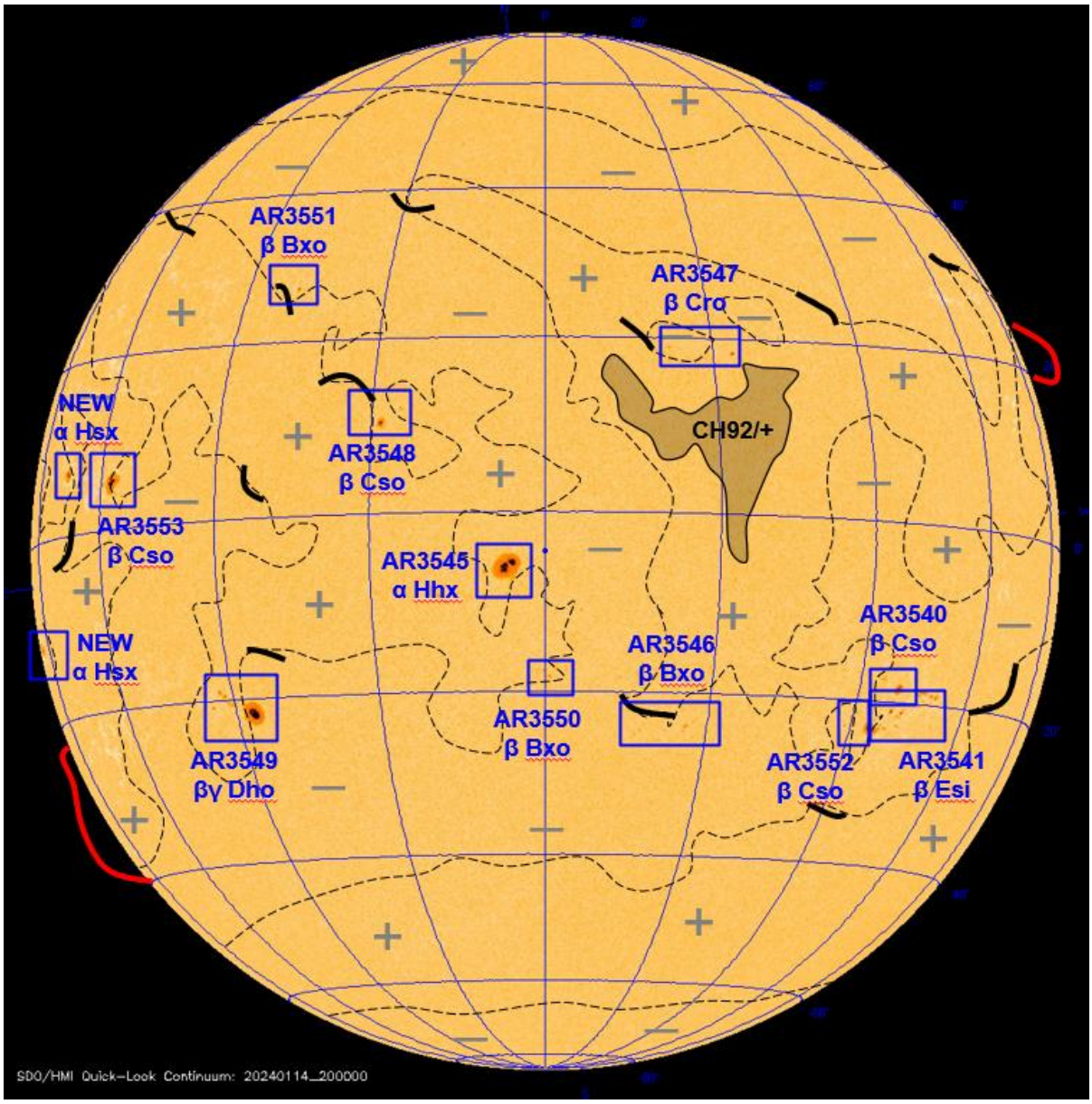
Overall, geomagnetic activity is likely to be Quiet (Kp 0-2) throughout, but with a chance of Unsettled to Active (Kp 3-4) intervals from days 2 or 3 (16-17 Jan) should we see any HSS influence from CH92/+.

Energetic Particles / Solar Radiation: High energy proton flux will most likely remain at background levels. Although, there remains an ongoing slight chance of seeing an increase to the S1/Minor Radiation Storm threshold, should any notable flares occur. The high energy electron flux is forecast to persist at background levels, with fluence below Active through this period. There is a chance of slight enhancement from day 4 (17 Jan).

Figure 1. Solar Analysis Valid 14/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

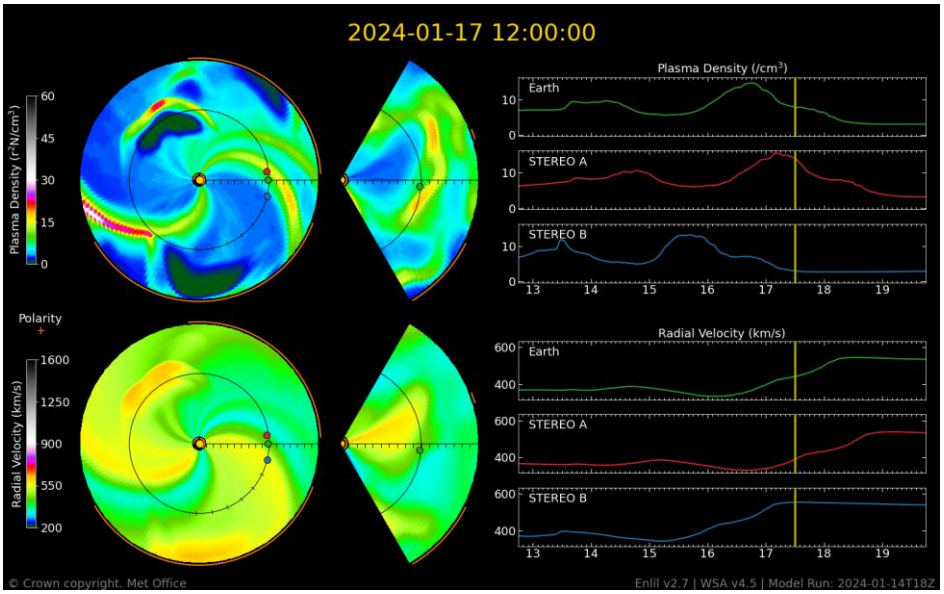
No Earth-directed CMEs currently feature in the forecast.

Solar wind speeds have ranged between 300-500km/s during the past 24 hours, although they are expected to remain at slow-ambient levels during day 1 (15 Jan). The main feature of interest in the forecast period is CH92/+, currently near centre disc in the northern hemisphere. This coronal hole is a persistent feature, but is much smaller than on previous rotation, with the leading edge further East than last time around. Wind speeds in the High Speed Stream (HSS) reached above 600 km/s on the previous rotation, on the equivalent of Day 1 (15 Jan). However, the much reduced size of the coronal hole suggests slower wind speeds of 450-500 km/s, which combined with the change in location, gives a potential arrival time later day 2 (16 Jan) or perhaps into day 3 (17 Jan). Recent Enlil runs support the idea of slight wind enhancement 16-18 Jan, with speeds of 400-450 km/s, largely representative of what is expected.

Overall, geomagnetic activity is likely to be largely Quiet (Kp 0-2), especially day 1 (15 Jan). There is a chance of Unsettled to Active (Kp 3-4) intervals from later day 2 (16 Jan) upon connection to the anticipated coronal hole HSS.

Geo-Magnetic Storm / Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil – shows the arrival of HSS from CH92 on either the 16-17 Jan.



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Radio Blackouts - X-Ray Flares:
Solar activity is at Low levels. The largest flare of the period was a C9.6 peaking at 14/1206 UTC, appearing to emanate from on or around the northwest limb, probably originating from Ex-AR3538 or Ex-AR3539.

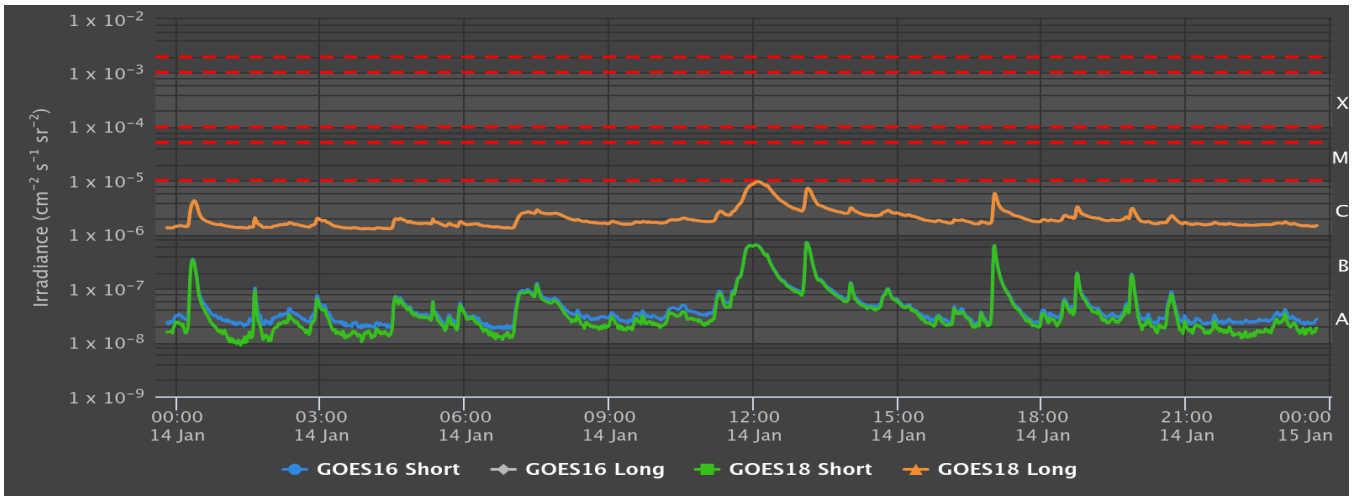
There are currently thirteen sunspots on the visible disc, two of which is unnumbered. Two large spots reside in the southeast, AR3545 and AR3549, these are both characterised by large leaders followed by small spots and pores of opposite polarities, the latter has a gamma configuration in the trailing region. The most complex region appears to be AR3541 in the southwest, which is set amongst a larger complex of sunspot regions. There is evidence of magnetic looping between these regions, which may result in increased instability. A new and unnumbered spot has appeared on the southeast horizon, although it is currently difficult analyse due to its location. All other spots remain small or simple at present.

Seismic analysis and recurrence would suggest that there are a number of regions which are due to return or rotate across the eastern limb through the period. This is supported by areas of brightness visible on EUVI/AIA 195 imagery suggesting the proximity of Carrington regions.

There is a chance of isolated M-flares throughout, with a slight chance of X-flares, perhaps most probable from the AR3541. There is an associated slight reduction in probabilities at this point, with an increase on day 4 (17 Jan) by which point a number of regions are expected to have rotated onto the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	45	45
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES X-Ray flares



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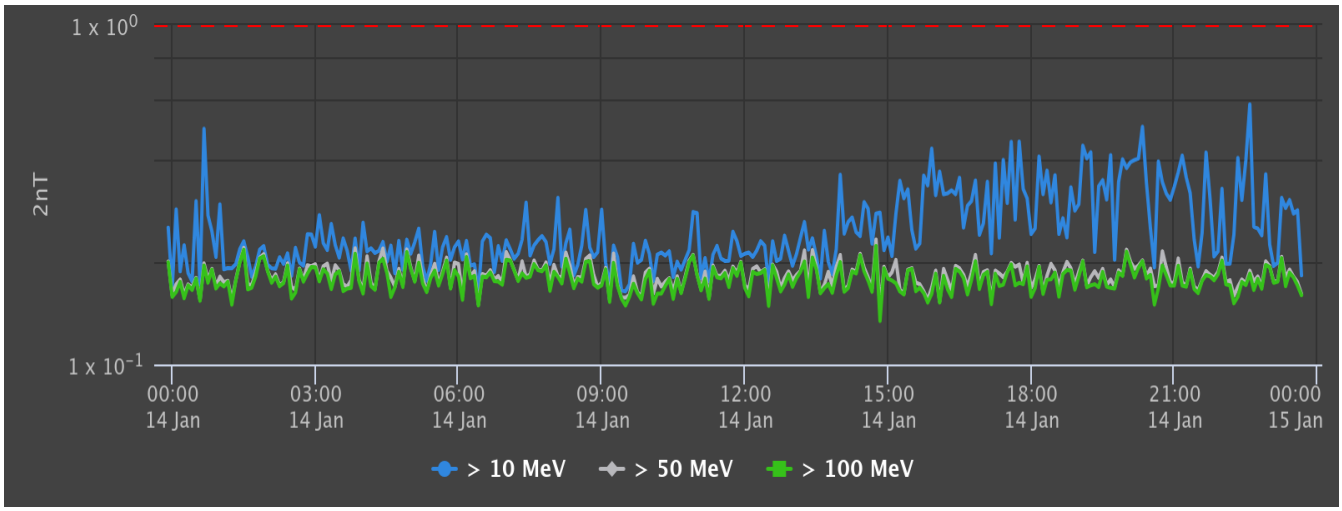
Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux is currently at background levels. Any further notable flares will bring a risk of proton flux rising, especially if they occur close to the western limb. Overall, there is a continuing slight chance of reaching the S1/Minor Radiation Storm threshold. With the probability maintained as a number of regions depart, whilst others rotate onto or across the visible disc.

Please note: GOES18 is currently being used as the primary proton instrument, with GOES16 data currently viewed as unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES Proton flux during past 24 hours.



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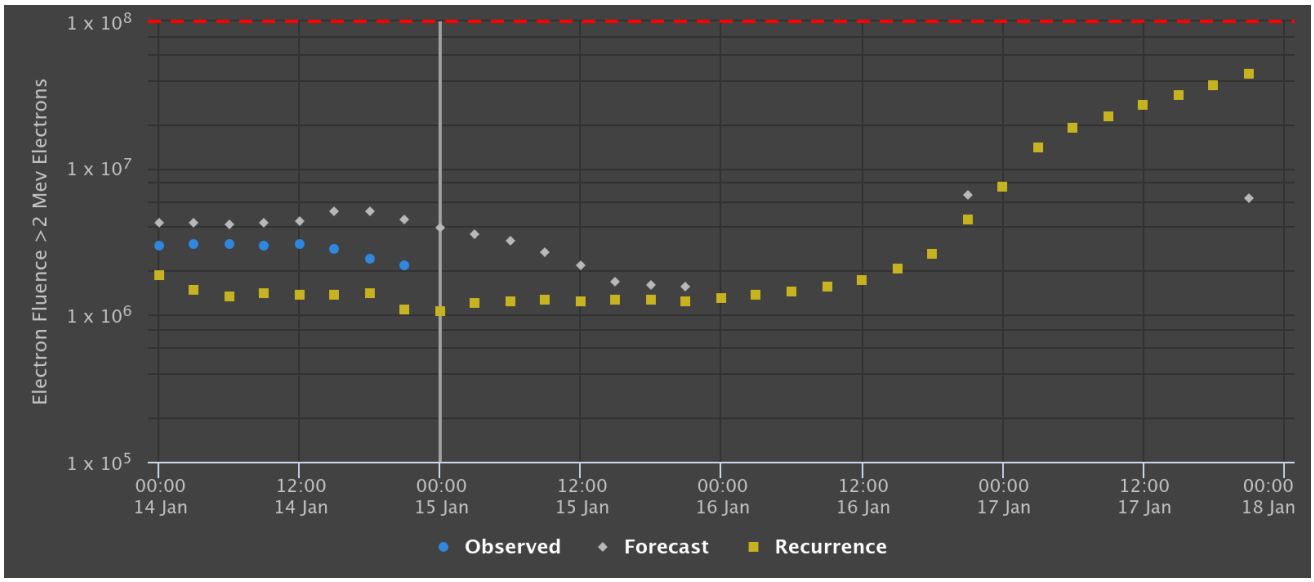
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) as measured by GOES16 at GEO is currently at background levels, and in the absence of any significant enhancement is expected to persist at this level throughout much of the forecast period.

Connection to a CH high speed stream may occur from late day 2 or day 3 (16-17 Jan), persisting until the end of the period, although any associated enhancement is not expected to produce any significant electron response until day 4 at the earliest.

MOSWOC REFM forecast values maintains fluence well below Active throughout the period, although the signal for a slight increase days 3-4 (17-18 Jan). This is considered good guidance. Recurrence would suggest fluence values may approach the Active level by the end of day 3 (17 Jan), however, the coronal hole is smaller and less pronounced and further East on this rotation so any enhancement is expected to be less significant and later than on the previous rotation.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM electron fluence, observations and recurrence.



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